#117
TL. 114-54/11

SECRET

DEPARTMENT OF THE AIR FORCE
Headquarters United States Air Force
Washington 25, D. C.

SCIENTIFIC ADVISORY BOARD TO THE CHIEF OF STAFF, USAF

# SCIENTIFIC ADVISORY BOARD REPORT ON AVRO PROJECT Y2

November 1954

This document consists of 10 pages
Copy Number 23A of 40 copies.

SECRET

Copy 1

DEPARTMENT OF THE AIR FORCE
Headquarters United States Air Force
Washington 25, D. C.

10 December 1954

Lieutenant General Donald L Putt
Deputy Chief of Staff, Development
Headquarters United States Air Force
Washington, D.C.

Dear Don:

In response to your request for SAB comments on the Avro "Saucer" project, the SAB has taken the following action:

The Aircraft and Propulsion Panels were briefed on September 28 by representatives of Hq. ARDC, at the time of the Fall meeting of the Board in Omaha. The tentative conclusions of both panels immediately after this briefing were to the effect that this project warranged no more than limited support. However, to assure thorough consideration of this project, I requested representatives of these two panels to supplement the briefings given to them at Omaha by a visit to A.V. Roe Canada Ltd., Malton, Ontario.

With the advice of Clark Millikan and Dean Soderberg, a select committee was chosen to conclude this study. It was composed of Dean Soderberg, Chairman of the Propulsion Panel and senior member of the group; Professor Markham, of the Aircraft Panel; and Mr. Donovan, who has been serving as a member of the Aircraft Panel and as liaison member with the Propulsion Panel.

The attached report of this group is forwarded with my approval, representing the results of the SAB's completed study.

Sincerely,

/s/
J. H. DOOLITTLE
Acting Chairman
Scientific Advisory Board
Office of the Chief of Staff

Inclosure

December 6, 1954

General James H. Doolittle, Acting Chairman
Scientific Advisory Board
Office of the Chief of Staff
Headquarters United States Air Force
Washington, D.C.

Dear General Doolittle:

At your request we constituted ourselves an ad hoc group to conclude the studies of the A.V. Roe Company project Y2, which was presented to the Scientific Advisory Board at the Omaha meetings in September of this year. We visited the A.V. Roe Company in Toronto on November 17 and 18. After considering the information available to us, we present the following report.

We wish to commend the officials of the A.V. Roe Company for a most courteous and well-planned reception, making the fullest possible use of the available time.

The Y2 is an airplane of circular plan form, originally built up around a radial flow turboject with the exhaust capable of being deflected downward in an annular jet for take-off and hovering near the ground. The airplane is designed for supersonic flight at high altitude, under which condition the exhaust jet is directed horizontally rearwards. The air is taken in vertically from the above for

hovering; for level flight the intake is changed to a normal frontal inlet by a set of slides and doors. In later versions the radial engine has been replaced by radially disposed axial flow turbojects of conventional type. This modification was originally considered as an intermediate version which might simplify the development procedure, but as the radial engine has been more realistically appraised, it is now looked upon as an alternative form of equal promise.

It is evident that the invention involves a whole array of formidable problems of research and development. Even in the smallest versions the outer diameter of the radial flow turbine is about twenty feet. The entire rotor must be supported on air bearings in the radial as well as the axial direction, and it is evident that the accompanying problems of mechanical design are very difficult. The design requires that very large air flow (a minimum of about 800 lb/s) be regulated by a complicated system of mechanical shutters on the inlet as well as on the outlet side. The problems of stability in hovering; in forward flight, and in the transition between the two modes naturally demand considerable attention. The many structural problems oq an unconventional nature likewise require much study. It is evident, even with only a casual study, that the process of development would be lengthy and costly in the extreme, even by present standards in military aircraft. The justification for entering into

such an undertaking must depend on (a) the significance of the objectives which the new airplane claims to fill and (b) the soundness of the means proposed to attain these objectives.

The key feature on which the design of the Y2 is based is the utilization for hovering of the pressure built up in the center of an annular jet stream. This pressure build-up increases the lift at standstill close to the ground in such a fashion as to indicate the practicability of hovering a few feet off the ground with engines whose static sea level thrust, without this augmentation from ground effect would be less than the airplane gross weight. Also, because of the nature of the ground effect, the aircraft would be stable with respect to height when hovering; that is, it would not require pilot attention to hold a height above the ground, although it would require control to maintain its attitude. The thrust augmentation for hovering obtained by A.V. Roe in small scale tests is of the order of 60 to 80%. Because the appropriate variables were not investigated and the pertinent measurements not made during the tests, data are not available to extrapolate this result properly to predict accurately full scale augmentation factors. There are many features which could make the full scale augmentation factors small but very little likelihood of their being larger than in the model. The possibility of stable hovering is, nevertheless, an engaging feature. Unfortunately, it has dominated the evolution of the con-

figuration to such an extent that performance in level flight is bound to have been seriously compromised. Since forward flight is, after all, the important feature of an airplane, we have attempted to examine into the inventors claim for the flight characteristics with particular care.

The inventor has advanced claims for favorable forward flight characteristics on the basis that the radial flow engine has a very favorable thrust to weight ratio (about .22); that the specific thrust on the projected area of the plane (about 600, including air intakes) is unusually high, and that the drag characteristics of the plane are very favorable. While not enough information is available to settle all of these points, we are compelled to take exception to all three of these claims. The specific engine weight is no longer unusual and would not in itself justify the radial engine development. Moreover, the radial engines possesses certain inherent limitations in pressure ratio and compossit efficiencies which are detrimental to good fuel consumption in comparision with the axial flow type. The shift to conventional turbojects has, of course, altered the situation, but it has not strengthened the claims based on the engine. The high thrust per frontal area is in part due to the fact that all discussions so far have been made around planes with no pay load. The situation with respect to drag appears to be the most serious, however, since we feel that the drag may have been underestimated by a factor of two. Very

lengthy and expensive exparirnents are needed to settle these questions with finality.

The inventor has assumed that some improvement in the drag situation might be obtained through boundary layer suction. The alleged gain from this source is associated with the distribution of the exhaust jet over the trailing edge of the airplane. It is not wholly impossible that such a gain might in fact be present, but no reliable test information is available at the present time on this point. In this respect this airplane differs from more conventional types only because the exhaust jet is distributed over the trailing edge of the wing. The circular plan form offers no particular advantage in this connection.

We are confronted, therefore, with an airplane development which does not appear to possess any intrinsic advantages either with the original radial engine or with the spoke arrangement of conventional turbojects. The pressure recovery on the induction side is certain to be poor for both alternatives; even with the utmost development of details it could not approach the performance of conventional airplanes. The ducting on the exhaust side presents equally formidable difficulties from the point of view of losses; and the gain due to boundary layer suction is only conjectural. These things might have been compensated for if the drag characteristics of the plane configuration could be demonstrated to be favorable. There is no

information to indicate that this is so. Sp basic laws appear to have been transgressed in the design. It is merely a question of overemphasis on the hovering characteristics without any assurance that the level flight charactertistics would be tolerable.

In arriving at a recommendation for action by the United States Air Force, we have attempted to bring into focus several considerations. The kind of imaginative thinking about unconventional aircraft which the inventor has displayed certainly has a place, and there is perhaps not enough of it in the planning operations of the USAF. When a scheme of this kind is ready for more serious exploitation, however, certain considerations are essential. The dreams must stand the test of hardheaded theoretical and experimental evaluation. The argument that such a procedure, if applied to aircraft developments fifty years ago, would have prevented powered flight is a specious one. The development of an engine such as the Y2, if it is to be carried to a flight article of some kind, is an undertaking of such a magnitude that it simply cannot be undertaken on a mere hunch. We do not feel that the inventor can support the claims he has made for it, particularly with reference to level flight. Moreover, we find a serious lack of attempt at a systematic exploration of the various key aerodynamic phenomena involved. There must also be a set of goals for the aircraft, which would place it in a class ahead of

other developments in performance if the basic ideas should be capable of realization. We do not feel that the objectives of the development have been clearly formulated. In particular, we feel that there has been a preoccupation with the hovering characteristics to such an extent that the most direct essentials of the aircraft have been lost sight of.

We do not question the ability of the A.V. Roe Company to undertake successfully any well-conceived project in the aircraft field which lies within their material resources. Our visit confirms our high opinion of their design and production activities in jet aircraft and engines. We have developed the suspicion, however, that the responsible designers in the A.V. Roe engineering groups are not thoroughly sold on the Y2 project. It is manifestly impossible for us to prove this contention or to make this assertion officially with the company. We feel convinced, however, that the best talents of the A.V. Roe organization have not been drawn upon in the evaluation of this project. This statement is made without prejudice toward the inventor, who impressed us as a talented and sincere man with a great deal of imagination, but who for this very reason cannot be expected to present a fully impartial critique. Full support from some of the leading designers outside of this particular group could perhaps have presented a more convincing argument for support.

On the basis of the above, we recommend against any contractural support for this project until much greater potentialities have been demonstrated by A.V. Roe's own analysis.

Sincerely yours,

Signed: Allen F. Donovan

John R. Markham

C. Richard Sonderberg, Chairman